Nuytsia

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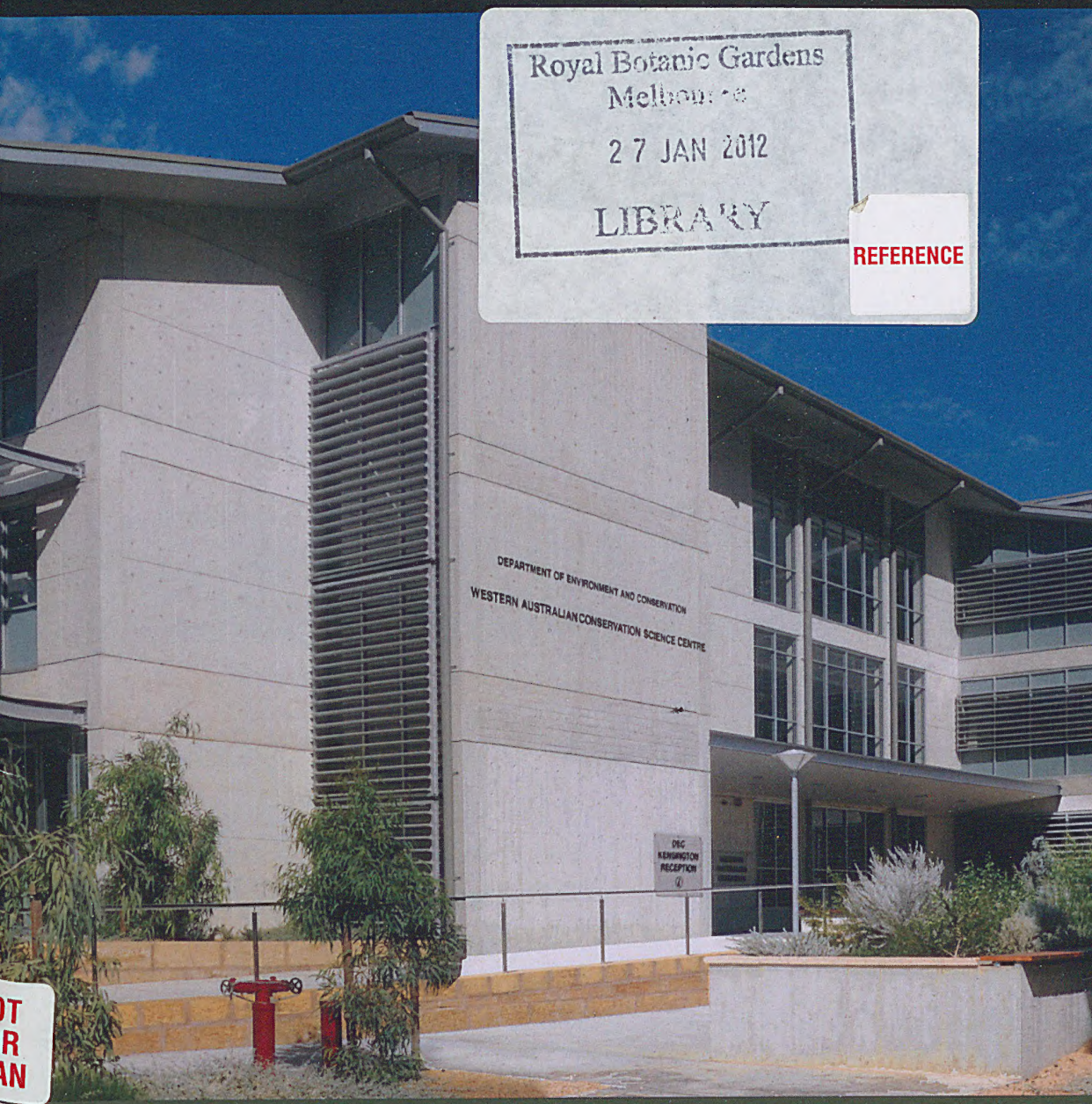

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The Department of Environment and Conservation's new Western Australian Conservation Science Centre, which incorporates the Western Australian Herbarium (PERTH).

Photograph: K.R. Thiele

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DEPARTMENT OF ENVIRONMENT AND CONSERVATION
WESTERN AUSTRALIA

Nutysia

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CONTENTS

Eremophila koobabbiensis (Scrophulariaceae), a new, rare species from the wheatbelt of Western Australia

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Abstract

Chinnock, R.J. & Doley, A.B. *Eremophila koobabbiensis* (Scrophulariaceae), a new, rare species from the wheatbelt of Western Australia. *Nuytsia* 21(4): 157–162 (2011). *Eremophila koobabbiensis* Chinnock, *sp.nov.*, is described and illustrated. This rare species is known only from one area north of Moora and its conservation is discussed. It is also established in cultivation and its long-term survival is assured.

Introduction

When the monograph of *Eremophila* and allied genera was published (Chinnock 2007) one of the authors of this paper (RJC) was aware of a number of undescribed species in Western Australia that had been seen in the field or had been isolated from existing herbarium collections but were either inadequate for the preparation of accounts for publication, or were discovered too late to be included in the monograph. Andrew Brown (Department of Environment and Conservation, Western Australia) also drew attention to other new species of which he was aware. Since the publication of the monograph, two new taxa, *E. grandiflora* A.P.Br. & B.Buirchell and *E. densifolia* F.Muell. subsp. *erecta* A.P.Br. & B.Buirchell have been published (Brown & Buirchell 2007).

In this paper a new and rare species is described and illustrated. *Eremophila koobabbiensis* is known only from Koobabbie Farm north of Moora usually as small numbers of scattered plants and these have been protected and conserved by the property owners (A.B. Doley and the late J. Doley), both of whom have had a long interest in native plants and their conservation. The two areas where the populations of *E. koobabbiensis* occurred were fenced off from stock in 1986 and 1991 at the owners' expense and they were advised in 1999 that it was a new species. The species was listed as Declared Rare Flora in 2005 under the *Western Australian Wildlife Conservation Act 1950* and listed as critically endangered in 2009 under the *Environment Protection and Biodiversity Conservation Act 1999*. An interim recovery plan for the species was published by Douglas in 2007.

Cutting material was obtained from a number of plants on a visit to Koobabbie in 2001 (RJC) and plants are now well established and preserved in cultivation in South Australia and Victoria. Plants are also grown at the Botanic Gardens and Parks Authority (Kings Park, Perth) and an approved replanting translocation project has also occurred on Koobabbie Farm.

Eremophila koobabbiensis Chinnock, *sp. nov.*

Frutex erectus ramis (et foliis, sepalis) dense glandularo-pubescentibus cum longior eglandularo-pubescentibus; foliis imbricates, ternato-verticillatis vel subternato-verticillatis, oblongis ad linearo-ellipticis lobis in 1–2 paribus raro aliquot integris; floribus solitaribus, sessilibus; sepalis valvatis, aequalis, linearo-lanceolatis; corolla lilacina ad dilute malvina, eglandularo-pubescentia; fructu sicco, ovoideo ad late ovoideo, villoso.

Typus: Koobabbie Farm, north of Moora, Western Australia, September 2001, *A. Doley s.n.* (*holo*: PERTH 06114555; *iso*: AD, B, CANB, K, MEL, MO).

Eremophila sp. Koobabbie (R.J.Chinnock 9540), C.Douglas, B.Todd & A.Brown, *Koobabbie poverty bush (Eremophila koobabbiensis ms): interim recovery plan, 2007–2012.*

Eremophila koobabbiensis Chinnock ms, Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed 23 July 2011].

Erect compact shrub to 1.6 m tall. *Branches* terete, smooth or with a few very obscure tubercles, densely pubescent with numerous short glandular hairs and longer, thin, often flexuose, white largely eglandular hairs. Leaves sessile, in whorls of 3 although often with one leaf displaced slightly further down the stem, erect, imbricate, obscuring branch, especially towards branch tips, oblong to linear-elliptic, distinctly lobed or rarely with a few entire; lobes in 1 or 2 pairs, obtuse, apex obtuse, 5.5–7 (–10.5) × 1.8–2.5 mm, surfaces faintly verrucose, shortly glandular-pubescent with longer thin weak eglandular hairs on margins and adaxial surface, pale green. *Flowers* 1 per axil, sessile. *Sepals* 5, valvate, linear-lanceolate, posterior one slightly shorter than other 4, acute, base distinctly fleshy, entire, with two rows of elongate translucent tubercles either side of midrib, 3.5–5 × 0.7–1 mm, outer surface with short glandular and longer eglandular ones, inner surface glandular-pubescent. *Corolla* 8–10 mm long, lilac to pale mauve, whitish on lower side outside and in the tube on lower side, lowermost lobe and inside of tube with irregular purple blotches; outside surface of lobes and tube eglandular pubescent, hairs slender; inside surface of upper 4 lobes glabrous, lowermost lobe prominently bearded with a dense mat of white hairs extending down the tube below it; glabrous elsewhere; tube constricted in lower part, narrow cylindrical, campanulate above; lobes obtuse. *Stamens* 4, included but upper two often extending just beyond throat, filaments white, glabrous; anthers blue, glabrous. Ovary oblong, 4-locular, with 1 ovule per locule. *Fruit* dry, ovoid to broadly ovoid, beaked, 3.5–4.5 × 2.5–3.5 mm; exocarp adhering to endocarp, densely white villous, with longer appressed eglandular hairs and short, obscure glandular ones; endocarp woody. *Seed c.* 2 × 0.7 mm, pale buff. (Figures 1, 2)

Other specimen examined. WESTERN AUSTRALIA: Koobabbie, 3 Dec. 2001, *R.J.Chinnock* 9540 (AD, PERTH).

Distribution and ecology. This species appears to be restricted to Koobabbie farm north of Moora where it has persisted in remnant degraded open *Eucalyptus* woodland of *E. salubris* (gimlet) and *E. salmonophloia* (Salmon gum) as seed presumably since 1906, when clearing commenced, until 1986 and 1991 when the areas were fenced off from livestock. Another *Eremophila* of conservation significance, *E. sargentii* (Priority Two), also occurs close to *E. koobabbiensis* at one site.

Flowering period. Although the main flowering occurs in spring during August and September, flowers occur sporadically at other times of the year.

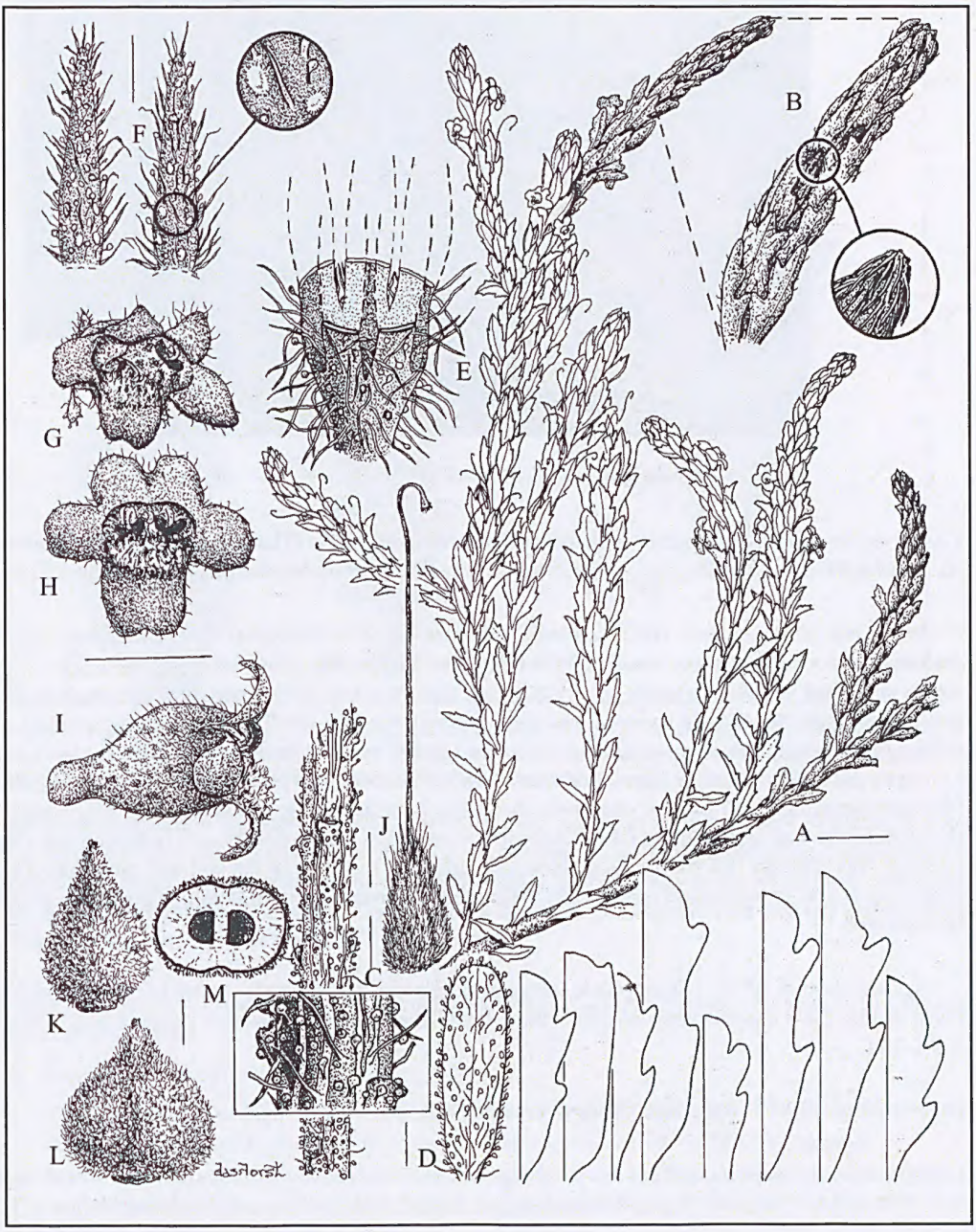

Figure 1. *Eremophila koobabbiensis*. A – branching arrangement; B – terminal portion of branch showing imbricate leaves and enlargement showing hairs; C – portion of branch with enlargement showing indumentums of long eglandular hairs and shorter glandular ones; D – leaf , with outlines showing variations in lobing and lobes restricted to the distal two thirds; E – basal portion of calyx showing valvate arrangement of sepals; F – outer and inner surface of sepal with enlargement showing glandular hairs and translucent spotting; G, H – front view of corolla; I – side view of corolla; J – gynoecium; K, L – side and front view of fruit; M – cross-section of bilocular fruit. (A–M, based on the type specimen). Scale bars: A = 5 mm; C = 1.5 mm; D = 1 mm; E, F = 1 mm; G–I = 5mm; J = 1 mm; K–M = 1 mm.

Figure 2. *Eremophila koobabiensis* (cultivated, ex *Chinnock* 9540)

Conservation status. The species is listed as *Declared Rare Flora* (Threatened) under the *Western Australian Wildlife Conservation Act 1950* and it is currently considered critically endangered.

When one of the authors (RJC) visited Koobabbie Farm in December 2001 there were seven mature plants occurring in two small populations about 3 kilometres apart, but in an interim recovery report published in 2007 (Douglas *et. al.*) only four mature plants were reported as occurring in one population. However, this is incorrect and until recently the two small populations still existed. A third natural population was located by one of us (ABD) in 2009 on Koobabbie Farm about one kilometre south-west from the population near Mamboobie road. This population consisted of at least 90 flowering plants to 0.7 m tall so they were thought to have been up to five years old. Unfortunately, this population was destroyed by rabbits later in the year after discovery through browsing and ring barking. Nevertheless this location should hold a rich seed resource in the soil and rabbit proofing of the site would be desirable to ensure any future seedling recruitment in favourable seasons would be protected.

A translocation of 74 young plants, propagated by cutting methods, occurred on Koobabbie Farm in July 2008 and currently 46 plants have established. These plants now range in height from 0.6–0.7 m.

Derivation of epithet. Taken from the farm to which this species is thought to be restricted.

Classification. Eremophila koobabbiensis belongs to *E.* section *Australophilae* and appears to be closest to *E. pinnatifida* Chinnock (Figure 3) which occurs further to the south-east near Dalwallinu.

The two species are well defined and readily distinguished. The terminal branches in *E. koobabbiensis* (including the appressed leaves) are of uniform width or slightly tapering towards the apices ranging from 4–5 mm broad (Figure 1B) whereas in *E. pinnatifida* they are distinctly dilated at the apices, 10–14 mm broad resulting from clustering of the developing terminal leaves (Figure 3B). The leaves of the two species are also markedly different. *Eremophila koobabbiensis* has leaves with few, usually irregularly arranged lobes which are cut into the lamina up to one third the way to the midrib. The

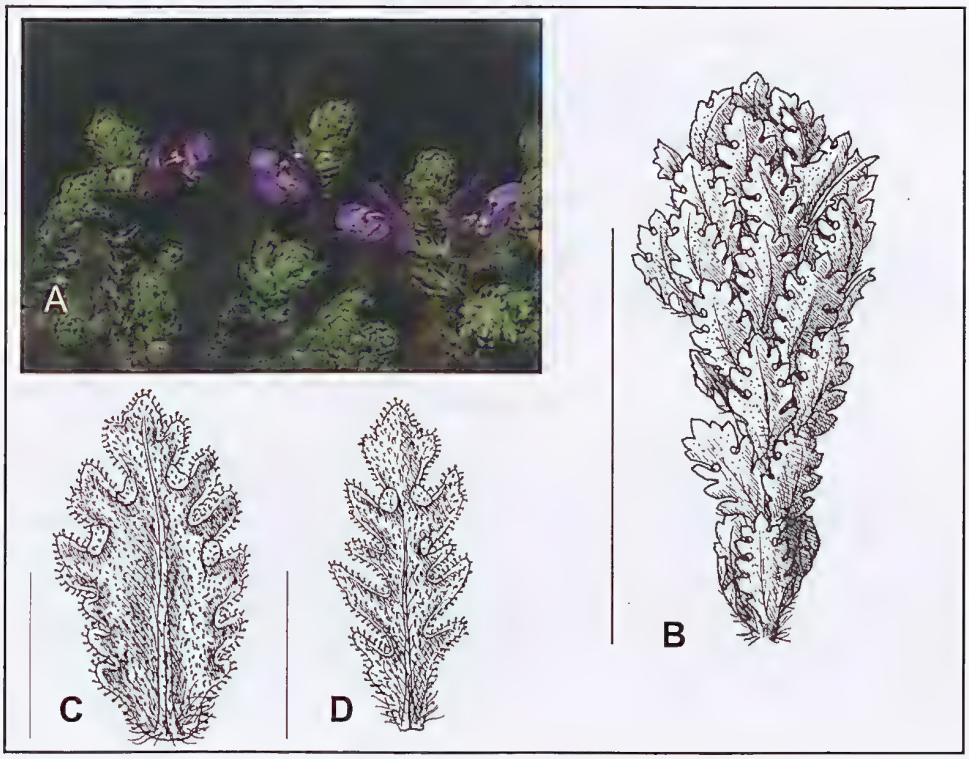

Figure 3. *Eremophila pinnatifida.* A – flowering branches (*Chinnock* 7966); B – dilated terminal portion of branch; C, D – undersurface of leaves showing the deeply dissected lobes and raised reflexed portions of lamina at the base of the sinus between some adjacent lobes. B–D (*Chinnock* 7971). Scale bars: B = 20 mm; C = 3 mm; D = 2.5 mm.

lobes are restricted to the upper two thirds of the leaf but mostly in the distal half. Occasionally a few leaves on a branch may be entire. The leaf of *E. pinnatifida* is uniformly lobed along both margins to near the leaf base and the lobes are cut into the lamina at least half way to the leaf midrib. In addition the portion of lamina at the base of the sinus between adjacent lobes is often reflexed and distinctly raised on the lower surface (Figure 3C, D).

In the monograph (Chinnock 2007), *E. koobabbiensis* falls within the Synopsis for sect. *Australophilae* (p. 230) in Group A.

A Leaves in distinct whorls of 3–5

1. Leaves flattened: 32, *ternifolia*, 36. *densifolia*, 46. *scaberula*, 49. *pinnatifida*, 49A. *koobabbiensis*
2. Leaves subterete: 21, *chamaephila*, 31. *verticillata*, 33. *veronica*, 34. *caerulea*, 47 *sargentii*

The key to species (Chinnock 2007: 231) can be adjusted as follows:

15 Leaves distinctly lobed
Leaves deeply lobed, lobes extending to near leaf base,
consisting of 4 or more pairs; corolla 18–25 mm long, pale to dark purple ..... **49. *E. pinnatifida***
Leaves shallowly lobed, lobes scattered and mostly restricted to the distal third to
half of the leaf, consisting of 1 to 2 pairs; corolla 8–10 mm long, pale lilac to
pale purple ..... **49A. *E. koobabbiensis***

15. Leaves entire..... **16**

Note. The authors prefer Koobabbie eremophila as a common name rather than Koobabbie poverty bush. This latter name adopted in the Interim Recovery Plan by Douglas *et al.* (2007) is considered inappropriate as 'poverty bush' has normally been applied to non-palatable eremophila species in the pastoral areas that tend to increase as land becomes degraded or over-grazed.

Acknowledgements

We wish to thank Mr Gilbert Dashorst for preparing the illustration of *Eremophila koobabbiensis* and Dr Hellmut Toelken for checking the Latin.

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A reinstatement and a new combination in *Leucopogon* (Ericaceae: Styphelioideae: Styphelieae)

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Abstract

Hislop, M. A reinstatement and a new combination in *Leucopogon* (Ericaceae: Styphelioideae: Styphelieae). *Nuytsia* 21(4): 163–176 (2011). The group of species synonymised by Bentham (1868) under *Leucopogon revolutus* R.Br. are re-examined and found to be heterogeneous. As a result *L. rubricaulis* R.Br. is reinstated. Two morphotypes identified within *L. obovatus* (Labill.) R.Br. (erroneously treated by Bentham as *L. revolutus*) are described as subspecies and the combination *L. obovatus* (Labill.) R.Br. subsp. *revolutus* (R.Br.) Hislop is here published. Descriptions and illustrations are provided for the three taxa treated and their distributions are mapped. Lectotypes are designated for *L. capitellatus* DC. var. *sparsiflorus* Sond., *L. revolutus*, *L. rubricaulis* and *L. villosus* R.Br.

Introduction

There has been long-standing confusion surrounding the taxonomy of several similar-looking *Leucopogon* R.Br. taxa from the south coast of Western Australia, which can be broadly characterized by their relatively long, narrow leaves with distinctly recurved or revolute margins. *Styphelia obovata* Labill. was the first name published (Labillardière 1805) in the group, and that species is also notable in being the first endemic Western Australian epacrid to be described. Five years later Robert Brown (1810) transferred it to his new genus *Leucopogon*. In the same publication Brown described another three species with similar foliar morphologies, *L. revolutus* R.Br., *L. rubricaulis* R.Br. and *L. villosus* R.Br., based on collections he made at King George Sound [Albany] and from two localities east of where the town of Esperance is now sited. Bentham (1837) added *L. angustatus* Benth. to the group, which was later followed by the infraspecific taxon, *L. angustatus* var. *hirsutus* Sond. (Sonder 1845). In his treatment of *Leucopogon* in *Flora Australiensis* however, Bentham (1868) not only changed his mind about the separate status of *L. angustatus*, but decided that the 'group' as a whole was better treated as a single variable species. While apparently recognising that *L. obovatus* had priority, he preferred to apply the name *L. revolutus*, which he thought more appropriate, and treated all of the others as synonyms. Blackall and Grieve (1981) continued to recognise only one species but, realizing that Bentham had erred in using *L. revolutus*, they returned to *L. obovatus*. Since the late 1990s both names have been included on the *Census of Western Australian Plants*, although in the absence of any published means of distinguishing between the two, they have been applied more or less arbitrarily.

The current paper revisits the taxonomy of this problematic group in the light of a much larger specimen base than was available to earlier workers, and after reference to the relevant type specimens.

Methods

This study was based on an examination of dried specimens housed at PERTH. The details of the methods used to measure plant parts and make other morphological observations are the same as those described previously (Hislop 2009a), except in relation to the inflorescence character of *Leucopogon rubricaulis*, which is of the type described for the *L. gracilis* group (Hislop 2009b). The basal point of the terminal inflorescence for that species is therefore taken to be the lowest axil from which a single flower arises (below which multi-flowered axillary inflorescences are usually present), and for axillary inflorescences, the point of attachment to the main axis. The fertile bract measurements are taken from the upper three inflorescence nodes only.

The distribution maps were compiled using DIVA-GIS Version 5.2.0.2 and based on PERTH specimen data.

Taxonomy

Leucopogon obovatus (Labill.) R.Br., *Prodr. Fl. Nov. Holl.* 542 (1810). *Styphelia obovata* Labill. *Nov. Holl. Pl.* 1: 48 (1805). *Type*: 'in terrâ Van-Leuwin' [near Esperance, Western Australia], 13–18 December 1792, *J.J.H. Labillardière s.n.* (*holo*: FI-W118462, image seen).

Erect, robust *shrubs* to *c.* 2.5 m high and 2 m wide, usually multi-stemmed at the base and at least sometimes with a fire-tolerant rootstock. Young *branchlets* with a moderately dense to dense indumentum, either monomorphic with short hairs to *c.* 0.1 mm or dimorphic with the layer of short hairs overtopped by a longer layer, 0.3–1.0 mm long, the short hairs patent, ± straight or slightly curved, the longer ones variously orientated, straight to distinctly curved. *Leaves* spirally arranged, mostly variously antrorse to ± patent, occasionally shallowly retrorse, shape very variable depending to a significant extent on the degree of curvature, from narrowly ovate or narrowly triangular to linear, oblong, elliptic or narrowly elliptic, to obovate, narrowly obovate or narrowly obtriangular, 6–23 mm long, 0.6–4.5 mm wide; apex obtuse to acute with a ± recurved callus point; base cuneate to rounded; petiole moderately well-defined, greenish-yellow to pale brown, 0.2–0.6 mm long, usually hairy at least in part, less often glabrous; lamina 0.15–0.25 mm thick, curvature variable, adaxial surface convex with the margins varying from slightly recurved with the abaxial surface visible throughout to revolute and the abaxial surface completely concealed, longitudinal axis ± straight; surfaces discolorous; adaxial surface shiny with a moderately dense to dense indumentum of short, tubercle-based, antrorse hairs, these often abraded on older leaves, the surface remaining verrucose, the venation usually quite distinct with 3–5 sunken veins evident, less often indistinct or barely evident; abaxial surface paler, usually hairy with either a short monomorphic indumentum or the indumentum variable and including some conspicuous, long hairs, sometimes glabrous, with 5–7 flat or slightly raised primary veins, the midrib usually somewhat more prominent than the others; margins either completely glabrous or minutely ciliolate with coarse, antrorse hairs to *c.* 0.05 mm long. *Inflorescences* erect, terminal and upper-axillary, usually aggregated into dense conflorescences; axis 3–28 mm long with 3–15 flowers, terminating in a bud-like rudiment or occasionally an attenuate point; axis indumentum of dense hairs 0.04–0.10 mm long; flowers erect and sessile. *Fertile bracts* ovate or broadly ovate, 0.5–1.3 mm long, 0.6–1.2 mm wide, obtuse or subacute. *Bracteoles* ovate, 1.0–2.1 mm long, 0.8–1.5 mm wide, obtuse to subacute,

keeled; abaxial surface with a sparse or moderately dense indumentum of short, often retrorse hairs, these sometimes confined to the keel, becoming scarious towards the margins; adaxial surface shortly hairy at least in the upper half; margins ciliolate. *Sepals* ovate or broadly ovate, 1.7–3.0 mm long, 1.1–1.8 mm wide, obtuse or occasionally subacute; abaxial surface usually hairy with a sparse to dense indumentum of short hairs, occasionally ± glabrous, the central portion pale greenish or straw-coloured, sometimes with reddish tinges towards the apex, becoming scarious towards the margins, the venation obscure; adaxial surface shortly hairy at least in the upper half; margins ciliate with hairs to *c.* 0.2 mm long. *Corolla tube* white, campanulate, or broadly so, shorter than the sepals, 1.0–2.0 mm long, 1.2–2.2 mm wide, glabrous externally and internally. *Corolla lobes* white, much longer than the tube (ratio = 1.4–2.5:1), widely spreading from the base and recurved, 2.2–3.5 mm long, 0.7–1.4 mm wide at base, glabrous externally, densely bearded internally; indumentum white, 0.5–1.0 mm long near apex; glabrous tip 0.2–0.3 mm long. *Anthers* partially exserted (by *c.* 7/8 of their length) to fully exserted from the tube, 1.2–2.2 mm long, recurved towards the apex; sterile tips white, usually fairly conspicuous, 0.3–0.6 mm long. *Filaments* terete, 0.7–1.4 mm long, attached 1/2–2/3 above anther base, adnate to tube just below sinus. *Ovary* ellipsoid, globose or depressed-globose, 0.5–0.8 mm long, 0.5–1.0 mm wide, glabrous, (4)5-locular. *Style* 0.3–0.8 mm long, either well-differentiated from the ovary apex, or poorly so and tapering ± evenly from apex to stigma, included within the corolla tube; *stigma* ± expanded and obscurely lobed; *nectary* annular, 0.25–0.45 mm long, entire or shallowly lobed, glabrous. *Fruit* broadly obovoid, globose to depressed-globose, 1.9–2.3 mm long, 1.9–2.6 mm wide, glabrous, with smoothly rounded shoulders, longer than the calyx, mesocarp well-developed, manifesting as an irregular, raised reticulum on dried specimens; style persistent.

Notes. *Leucopogon obovatus* is a robust, floriferous plant with a distribution of at least 900 km along the southern coast of Western Australia. It is among the State's most frequently collected epacrids, and one which exhibits considerable variation. An examination of the large holding of this taxon (*c.* 400 specimens) at PERTH, indicates that two geographically-based morphotypes are present but with intermediates where their ranges overlap. The main differences indicative of this divergence are vegetative with some support from a correlating floral character. Infraspecific rank is chosen here as the best reflection of the nature and geographical distribution of these differences and the fact that a significant level of intergradation occurs in the relatively small area where the two are sympatric.

Key to subspecies of *Leucopogon obovatus*

1. Branchlet indumentum monomorphic, with short hairs to *c.* 0.1 mm long, but usually less; leaf shape, when recurved margins are flattened, obovate, narrowly obovate, elliptic or narrowly elliptic, the widest point at or above the middle; leaf abaxial surface usually with short hairs only, less often glabrous; style 0.5–0.8 mm long (near-coastal areas between Denmark and Israelite Bay)..... subsp. **obovatus**

1: Branchlet indumentum dimorphic, with a layer of short hairs overtopped by a distinctly longer layer, the latter 0.3–1.0 mm long; leaf shape, when recurved margins are flattened, narrowly ovate or narrowly elliptic (usually very narrowly so), the widest point at or below the middle; leaf abaxial surface usually with a mixture of long and short hairs, occasionally with short hairs only or glabrous; style 0.3–0.5 mm long (Margaret River area to Albany and inland as far as the Stirling Range) ..... subsp. **revolutus**

a. Leucopogon obovatus (Labill.) R.Br. subsp. obovatus

Young *branchlets* with a monomorphic indumentum of short hairs to *c.* 0.1 mm long. *Leaves* in natural posture linear, oblong, obovate, narrowly obovate or narrowly obtriangular, when recurved margins are flattened, obovate, narrowly obovate, elliptic or narrowly elliptic; abaxial surface with short hairs only, or sometimes glabrous. *Style* 0.5–0.8 mm long, always well-differentiated from the ovary apex. (Figures 1, 4B)

Selected specimens examined. WESTERN AUSTRALIA: Michaelmas Island, King George Sound, Albany, Sep. 1975, *I. Abbott* 47 (PERTH); Point Charles, Fitzgerald River Reserve [National Park], 5 Aug. 1970, *M.I.H. Brooker* 2738 (NSW, PERTH); Cape Le Grande National Park. Between Rossiter Bay carpark and the Bird Sanctuary, 24 Sep. 1985, *M. Carter* 142 (NSW, PERTH); near campsite, Bald Island, 16 Oct. 2003, *J.A. Cochrane & S. Comer* 28 (PERTH); Lort River, *c.* 200 m downstream of South Coast Highway, 16 Nov. 1993, *B.J. Conn* 4002 & *A.N.L. Doust* (MEL, NSW, PERTH); carpark at lookout, Tagon Bay, Cape Arid National Park, 7 Oct. 2003, *D.M. Crayn* 672, *K.A. Kron & A.J. Perkins* (NSW, PERTH, WFU); Hillman Street, Spencer Park [Albany], 14 Mar. 1989, *E.J. Croxford* 5414 (PERTH); Granite quarry, 2 km W of Marra Bridge, Hassell Highway, E of Albany, 23 Sep. 1987, *E.J. Croxford* 5937 (PERTH); environs of camping area, Waychinicup National Park, close to mouth of Waychinicup River, 26 Aug. 2006, *M. Hislop* 3636 (CANB, PERTH); Frenchman Bay, Albany, 1 km SE of Albany, 26 Oct. 1985, *N. Hoyle* 1341 (CANB, PERTH); Middle Island, Recherche Archipelago, 9 May 1991, *G.J. Keighery* 12369 (CANB, PERTH); Oldfield River on S side, 13 km WSW of Munglinup, *c.* 100 m W of crossing at intersection of Oldfield River and Coxall Rd, 28 Oct. 1998, *M.N. Lyons & S.D. Lyons* 3578 (PERTH); Millers Point, Beaufort Inlet, 18 Oct. 1964, *K.R. Newbey* 1520 (PERTH); Mylies Beach campsite area, Fitzgerald River National Park, 14 July 1982, *J.M. Powell* 1800 (CANB, K, L, MEL, NSW, PERTH); near Little Tagon Bay, Cape Arid National Park, 17 July 1982, *J.M. Powell* 1842 (CANB, K, L, MEL, NSW, PERTH); Stokes Inlet National Park, 20 July 1982, *J.M. Powell* 1883 (CANB, HO, K, L, MEL, NSW, PERTH); coast immediately W of West Cape Howe [W of Denmark], 26 July 1982, *J.M. Powell* 1975 (CANB, K, NSW, PERTH); on Condingup Hill *c.* 69 km E of Esperance, 1 Oct. 1970, *R.A. Saffrey* 1272 (PERTH); end of Rabbit Proof Fence, Starvation Bay, 75 km SE of Ravensthorpe, S of Springdale Rd, 19 Aug. 2001, *A. Williams* 305 (PERTH); Bremer Bay, 1 Oct. 1966, *P.G. Wilson* 4300 (CANB, NSW, PERTH).

Distribution and habitat. Widely distributed in near coastal localities between West Cape Howe and Israelite Bay (Figure 2), in the Esperance Plains and Jarrah Forest IBRA bioregions (Department of the Environment, Water, Heritage and the Arts 2008). Grows mostly on sand or sandy loam soils in heath or low woodland. It is frequently a dominant taxon on coastal dunes but also occurs over granite, limestone or quartzite and occasionally on subsaline flats.

Phenology. Flowers and/or fruit are present during much of the year, but with a flowering peak between July and October.

Conservation status. A widespread and common taxon.

Notes. The subspecies retain their differences across most of the wide range of *L. obovatus*. However in the Albany–Denmark area where their distributions overlap the two are quite frequently difficult to separate. In this area plants may have a morphology that is quite typical of one or the other subspecies (e.g. *J.M. Powell* 1975 & *I. Abbott* 47 for subsp. *obovatus* or *P. Foreman* 62 & *K. Baker* 10 for subsp. *revolutus*) or be intermediate between them (e.g. *C.A. Hortin* 6/59.4, *L.J. Pen* LJP 56 & *N. Gibson*

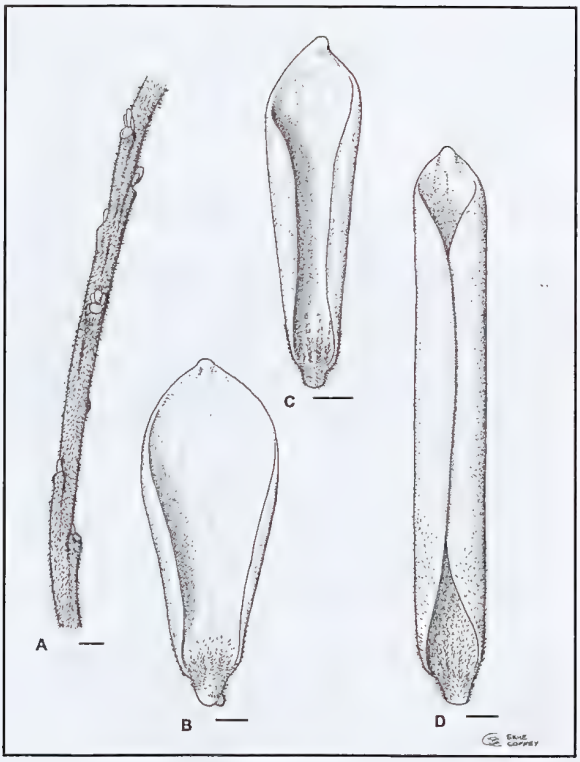

Figure 1. *Leucopogon obovatus* subsp. *obovatus*. A – indumentum on young branchlet; B–D – leaf variation, abaxial surface. Scale bars = 1 mm. Drawn by Skye Coffey from *M.N. Lyons & S.D. Lyons* 3578 (A), *J.M. Powell* 1842 (B), *E.J. Croxford* 5414 (C), *E.J. Croxford* 5937 (D).

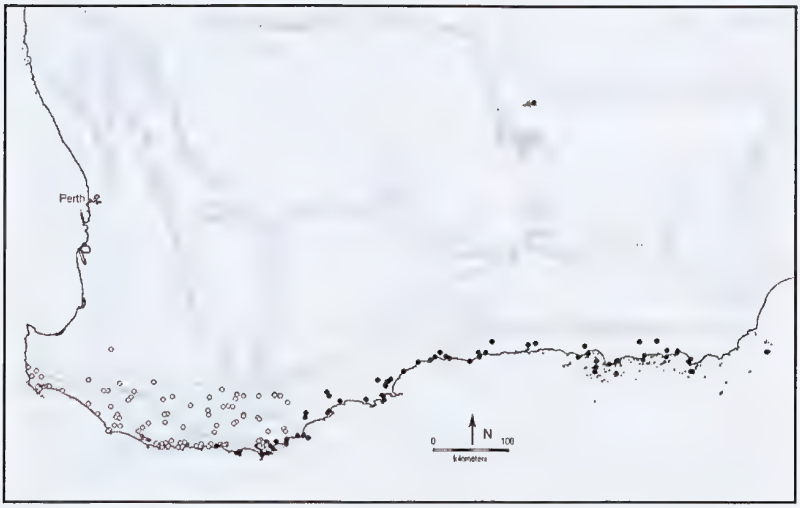

Figure 2. Distribution of *Leucopogon obovatus* subsp. *obovatus* (●) and *L. obovatus* subsp. *revolutus* (○) in southern Western Australia.

& M. Lyons 738). These intermediates generally have the leaf shape of subsp. *revolutus*, although always lacking long hairs on the abaxial surface. The branchlet indumentum may be of two kinds: either mostly short but with a few irregularly distributed, longer hairs, or less often monomorphic and then with a hair length longer than normal for subsp. *obovatus*.

b. Leucopogon obovatus (Labill.) R.Br. subsp. **revolutus** (R.Br.) Hislop, *comb. et stat. nov.*

Leucopogon revolutus R.Br., *Prodr. Fl. Nov. Holl.* 542 (1810). *Styphelia revoluta* (R.Br.) Spreng., *Syst. Veg.* 1: 657 (1824). *Type*: King George Sound [Western Australia], December 1801–January 1802, *R. Brown s.n.* (*lecto*, here designated: BM 001040176, image seen); Lucky Bay [E of Esperance, Western Australia], January 1802, *R. Brown s.n.* (excluded *syntypes*: K 000348369, K 000348370, images seen) = *L. obovatus* subsp. *obovatus*; Goose Island [Recherche Archipelago, Western Australia], May 1803, *R. Brown s.n.* (excluded *syntypes*: BM 001040177, K 000348374, K 000348377, images seen) = *L. obovatus* subsp. *obovatus*.

[*Styphelia obovata* Labill. var. *angustior* F.Muell., *Fragm.* 6: 31 (1867). *Type*: none cited.]

[*Styphelia obovata* Labill. var. *angustissima* F.Muell., *Fragm.* 6: 31 (1867). *Type*: none cited.]

Young *branchlet* indumentum dimorphic, with a layer of short hairs overtopped by a distinctly longer layer, 0.3–1.0 mm long. *Leaves* in natural posture linear, oblong, narrowly ovate or narrowly triangular, when recurved margins are flattened, narrowly ovate or narrowly elliptic; abaxial surface usually with a mixture of short and obviously longer hairs, or sometimes glabrous. *Style* 0.3–0.5 mm long, either fairly well-differentiated from the ovary apex or tapering ± smoothly from the ovary apex to the stigma. (Figure 3)

Selected specimens examined. WESTERN AUSTRALIA: parking area at start of track up Mt Chudalup, 200 m from Wheatley Coast Highway [Rd], 16 km SSW of Northcliffe, 9 Oct. 1997, *E.A. Brown* 97/255 *& G. Taaffe* (CHR, NSW, NY, PERTH, UNSW); intersection of Caves Rd and Bussell Highway [N of Augusta], 20 m from road, 11 Oct. 1997, *E.A. Brown* 97/270 *& G. Taaffe* (CANB, NSW, NY, PERTH, UNSW); 20.6 km W of Denmark on Denmark–Walpole Rd, 26 Aug. 1986, *A.R. Chapman* 385 (NSW, NY, PERTH); 1 km W of Hay River on Spencer Rd [SW of Mt Barker], 29 Aug. 1986, *A.R. Chapman* 406 (HO, NSW, PERTH); Lake Seppings, Albany, 30 Sep. 1984, *R.J. Cranfield* 4951 (HO, PERTH); 2 km SSE of Quinninup, 11 Oct. 1999, *R.J. Cranfield* 14040 (CANB, PERTH); carpark at entrance to Treetop Walk, Valley of the Giants, Walpole-Nornalup National Park, 10 Oct. 2003, *D.M. Crayn* 707, *K.A. Kron & A.J. Perkins* (NSW, PERTH, WFU); Willyung Hill, about 12 km N of Albany, 23 Sep. 1984, *D.B. Foreman* 825 (AD, MEL, NSW, PERTH); N part of Porongurup National Park, 1.5 km W of the ranger's residence along scenic drive, 21 Oct. 1991, *W. Greuter* 23062 (PERTH); South Sister Nature Reserve, NE of Albany, along E boundary of southern block, 17 Nov. 2003, *M. Hislop* 3095 (NSW, PERTH); Transect 5, Lake Noobijub. On SE edge of lake, *c.* 450 m around from inlet drain, *c.* 25 km NW of Rocky Gully, 31 Oct. 2001, *B. Muir* 95 (PERTH); [Mount] Toolbrunup, Stirling Range National Park, 14 Aug. 1981, *B.F. Palser* 49 (PERTH); Boat Harbour Rd, *c.* 4 km SW of South Coast Highway, 25 July 1982, *J.M. Powell* 1961 (K, L, NSW, PERTH); near the Knoll and Nornalup Inlet, Walpole–Nornalup National Park, 14 Aug. 1979, *J.M. Powell* 1163 (BISH, CANB, K, L, NSW, PERTH); Blue Lake Rd, 12.3 km from junction with Denmark–Mount Barker Rd, 24 July 1982, *J.M. Powell* 1955 (CANB, K, L, MEL, NSW, PERTH); Geekabee Hill, W of Cranbrook, 4 Aug. 1986, *J.M. Powell* 2434A (HO, NSW, PERTH); 4 km N of Augusta, at turn-off to Yallingup, 24 Aug. 1986, *J.M.*

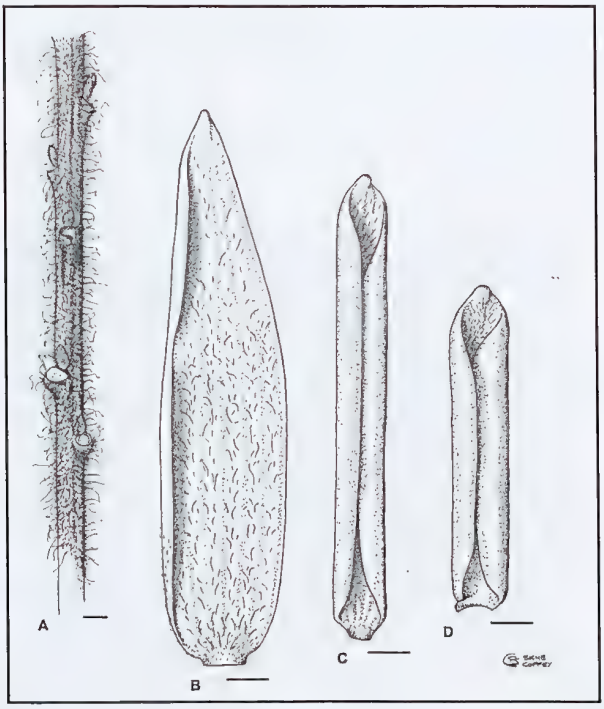

Figure 3. *Leucopogon obovatus* subsp. *revolutus*. A – indumentum on young branchlet; B–D – leaf variation, abaxial surface. Scale bars = 1 mm. Drawn by Skye Coffey from *R.J. Cranfield* 14040 (A), *J.M. Powell* 2646 (B), *J.M. Powell* 1961 (C), *W. Greuter* 23062 (D).

Powell 2612 (HO, NSW, PERTH); Windy Harbour area, 1–2 km E of Pt D'Entrecasteaux lighthouse, 25 Aug. 1986, *J.M. Powell* 2646 (NSW, NY, PERTH); Scott National Park, SW corner, 12 Oct. 1990, *C.J. Robinson* 185 (PERTH); Napier Creek crossing along the Chester Pass Rd [NE of Albany], 1 Sep. 1986, *P.S. Short* 2598, *M. Amerena & B.A. Fuhrer* (MEL, NSW, PERTH).

Distribution and habitat. Extends from a little south of Margaret River to the Albany area and then north as far as Wheatley [N of Manjimup] and the Stirling Range (Figure 2). This places it mainly in the Warren and Jarrah Forest IBRA bioregions (Department of the Environment, Water, Heritage and the Arts 2008) with a limited occurrence in the far west of the Esperance Plains bioregion. Grows in deep sand, sandy loam or less often loam soils, sometimes over laterite or granite, and as a component of dry or occasionally winter-wet heath, woodland or forest.

Phenology. Mostly flowers between late July and the end of October.

Conservation status. A widely distributed and common taxon in the wetter parts of the south-western corner of Western Australia

Affinities. In addition to the characters used to separate the two in the key above, it is noteworthy that the leaves of subsp. *revolutus* usually have a noticeably longer and narrower aspect than those of the typical subspecies. This subspecies may also be mistaken for *L. capitellatus* DC., another member

of the *L. australis* group (*sensu* Hislop & Chapman 2007). These two are sympatric throughout the range of subsp. *revolutus* but there is no evidence of hybridization or intergradation. The two can be distinguished using the foliar characters in Table 1.

Table 1. Morphological differences between *Leucopogon obovatus* subsp. *revolutus* and *L. capitellatus*

	L. obovatus* subsp. *revolutus	***L. capittellatus***
Leaf curvature	Adaxial surface usually strongly convex, the margins usually manifestly recurved or revolute, and obscuring at least a portion of the abaxial surface, although in a few leaves the abaxial surface may be visible throughout.	Adaxial surface ± flat to slightly concave, if the margins somewhat recurved, then the abaxial surface still clearly visible throughout.
Leaf margins	Apparently glabrous or sometimes minutely ciliolate under high magnification, with hairs to 0.05 mm long.	Manifestly ciliate with hairs 0.05–0.20 mm long.
Leaf apex	Obtuse or rather abruptly contracted to a blunt point.	Smoothly attenuate.

Notes. In his treatment of *Leucopogon obovatus* (as *Styphelia obovata*) in *Fragmenta Phytographiae Australiae*, Mueller (1867) listed two varieties, var. *angustior* F.Muell. and var. *angustissima* F.Muell. Neither of these names were widely adopted. The former does not appear at all in the subsequent literature, and while the latter is included in the online Australian Plant Name Index (APNI: Australian National Botanic Gardens 1991–), the name has apparently never been used in Western Australia. The fact that no types were nominated and that efforts to find potential type specimens have proven fruitless, suggests that it may well never have been the author's intention to formally publish these varieties. However, to judge by Mueller's scant descriptions, and the localities given, it is probable that both are referrable to *L. obovatus* subsp. *revolutus*.

Typification. Brown based the name *Leucopogon revolutus* on collections he made at King George Sound [Albany], Goose Island and Lucky Bay [both east of Esperance]. The single specimen from the former locality at the Natural History Museum, London is chosen as the lectotype for that name. Although both subspecies occur in the Albany area, Brown's collection from King George Sound clearly has the characteristic, dimorphic indumentum described above for subsp. *revolutus*. Specimens from Goose Island and Lucky Bay are of the same taxon as the type of *Styphelia obovata* collected at Esperance Bay, and are therefore representative of the typical subspecies of *L. obovatus*.

Leucopogon rubricaulis R.Br., *Prodr. Fl. Nov. Holl.* 542 (1810). *Styphelia rubricaulis* (R.Br.) Spreng., *Syst. Veg.* 1: 656 (1824). *Type*: King George Sound [Western Australia], December 1801, *R. Brown s.n.* (*lecto*, here designated: BM 000907505!).

Leucopogon villosus R.Br., *Prodr. Fl. Nov. Holl.* 542 (1810). *Styphelia villosa* (R.Br.) Spreng., *Syst. Veg.* 1: 657 (1824). *Type*: King George Sound [Western Australia], December 1801, *R. Brown s.n.* (*lecto*, here designated: BM 000907504!).

Leucopogon angustatus Benth., in S.F.L.Endlicher, E.Fenzl, G.Bentham, & H.W.Schott, *Enum. Pl.*: 77 (1837). *Type*: King George Sound [Western Australia, 1–11 January 1834], *C.A.A.F. von Hügel s.n.* (*iso*: MEL 78331!).

Leucopogon angustatus Benth. var. *hirsutus* Sond., in J.G.C.Lehmann, *Pl. Preiss.* 1: 311 (1845). *Type*: In regionibus interioribus Australiae meridionali-occidentalis, *L. Preiss* 394 (*syn*: LD 1000221, image seen).

Leucopogon sp. Denmark (J.M. Powell 1167), in G.Paczkowska & A.R.Chapman, *West. Austral. Fl.: Descr. Cat.*: 240 (2000); in J.Wheeler, N.Marchant, & M.Lewington, *Fl. South West* 2: 603 (2002).

Erect, open *shrubs* to 1.5 m high and 1.5 m wide, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* usually glabrous or with a sparse to moderately dense (rarely dense), ± monomorphic indumentum of patent, straight or decurved hairs, 0.02–0.40 mm long. *Leaves* spirally arranged, variously orientated, from steeply antrorse to steeply retrorse, narrowly ovate to narrowly elliptic (where leaf margins are slightly recurved only) or oblong to linear (where strongly recurved or revolute), 4.5–18.0 mm long, 0.7–2.8 mm wide; apex acute, subacute or obtuse with a ± recurved callus point; base attenuate or cuneate; petiole broad, rather poorly defined, cream-coloured to pale brown, to *c.* 0.5 mm long, usually glabrous on abaxial surface and hairy on adaxial surface and margins, occasionally hairy throughout; lamina 0.15–0.25 mm thick, curvature variable, adaxial surface convex with the margins varying from slightly recurved with the abaxial surface visible throughout to revolute and the abaxial surface completely concealed, longitudinal axis usually ± straight, sometimes distinctly recurved; surfaces discolorous; adaxial surface shiny, usually glabrous to moderately hairy (rarely densely so), the venation usually indistinct but sometimes 3–5 sunken veins evident; abaxial surface paler, usually glabrous, but occasionally sparsely hairy, with 5–7 pale, flat or slightly sunken primary veins, the midrib often raised and rather thicker towards the apex; margins glabrous or irregularly ciliolate with coarse hairs to *c.* 0.3 mm long. *Inflorescences* erect, terminal and upper-axillary, often aggregated into dense conflorescences; axis 4–10 mm long with 4–13 flowers, terminating in a bud-like rudiment or an attenuate point; axis indumentum of moderately dense or dense patent hairs, 0.02–0.08 mm long; flowers erect and sessile. *Fertile bracts* ovate, 1.4–2.0 mm long, 0.9–1.3 mm wide, acute to obtuse. *Bracteoles* ovate, 1.4–2.4 mm long, 0.8–1.2 mm wide, obtuse, subacute or acute, sharply keeled; abaxial surface glabrous or with a sparse to moderately dense indumentum of short hairs, often with a few longer hairs about the keel, becoming scarious towards the margins; adaxial surface shortly hairy in the upper half or throughout; margins ciliolate. *Sepals* ovate or narrowly ovate, 2.0–2.8 mm long, 1.0–1.4 mm wide, obtuse or occasionally subacute; abaxial surface glabrous or with a variable, very short indumentum, the central portion pale greyish green, usually tinged reddish purple towards the apex and in a submarginal band, becoming scarious towards the margins, the venation usually obscure, although sometimes the midrib and the two nearest lateral veins ± conspicuous towards the apex; adaxial surface shortly hairy towards the apex; margins ciliate with hairs to 0.2 mm long. *Corolla tube* white, campanulate, shorter than the sepals, 1.1–1.7 mm long, 1.0–1.4 mm wide, glabrous externally and internally. *Corolla lobes* white or pink, much longer than the tube (ratio = 1.6–2.4:1), widely spreading from the base and recurved, 2.3–3.3 mm long, 0.5–0.9 mm wide at base, glabrous externally, densely bearded internally; indumentum white, 0.8–1.2 mm long near apex; glabrous tip 0.15–0.25 mm long. *Anthers* partially exserted from the tube (by 3/4–7/8 of their length), 1.3–2.0 mm long, recurved often strongly towards the apex; sterile tips white, conspicuous, 0.3–0.7 mm long. *Filaments* terete, 0.5–0.8 mm long, attached 1/2–2/3 above anther base, adnate to tube just below sinus. *Ovary* broadly obovoid or ± globose, 0.4–0.6 mm long, 0.4–0.6 mm wide, usually with short hairs in the upper half, occasionally glabrous, 4–5-locular. *Style* 0.5–0.8 mm long, well-differentiated from ovary apex, included within the corolla tube; *stigma* not

or scarcely expanded; *nectary* annular 0.20–0.35 mm long, entire or very shallowly lobed, glabrous. *Fruit* oblongoid to narrowly ellipsoid, 3.0–3.9 mm long, 1.3–1.8 mm wide, much longer than the calyx, truncate with a broad, obscurely lobed rim, the surface between the rim and the style base descending steeply, usually shortly hairy about the apex, the hairs sometimes only on the descending surface and therefore difficult to see, occasionally glabrous, the surface grooved longitudinally, but otherwise smooth; style persistent. (Figure 4A)

Selected specimens examined. WESTERN AUSTRALIA: 1.3 km N along Nutcracker Rd from junction of Ficifolia Rd, NW of Peaceful Bay, 22 Oct. 2007, *R. Davis s.n.* (NSW, PERTH); Denmark Shire; Denbarker State Forest, 'the sand track', 3.1 km W from Denmark–Mount Barker Rd towards Stan Rd, 3 Sep. 1994, *B.G. Hammersley* 1125 (CANB, PERTH); access track to Granite Hill Nature Reserve, 1.4 km E of Moorialup Rd at junction of minor track, E of Porongurup, 16 Nov. 2003, *M. Hislop* 3089 (NSW, PERTH); Mount Barker–Denmark Rd, 2.3 km S of Spencer Rd, 1 Sep. 2005, *M. Hislop* 3502 (CANB, PERTH); Survey Downs Rd, *c.* 1 km N of Mt Barker–Porongurup Rd, locality of Porongurup, 3 Sep. 2005, *M. Hislop* 3510 (CANB, PERTH); Gull Rock Rd, 4 km N of Gull Rock, E of Albany, 15 Aug. 1986, *G.J. Keighery* 8316 (PERTH); Millbrook Nature Reserve, 25 km NNW of Albany, 8 Sep. 1987, *G.J. Keighery & J.J. Alford* 1644 (PERTH); Woolbale Hills, D'Entrecasteaux National Park, 6 Oct. 1997, *E.D. Middleton* EDM 63 (PERTH); 750 m N of the coast in Nuyts Wilderness, 2 km E of Poison Hill, 6 Oct. 1997, *E.D. Middleton* EDM 73 (PERTH); on edge of Cephalotus swamp, C. Milton's property, 3 km S of Mount Barker, 28 Mar. 1975, *K.F. Kenneally* 4580 (PERTH); near the Knoll and Nornalup Inlet, Walpole-Nornalup National Park, 14 Aug. 1979, *J.M. Powell* 1170 (CANB, CBG, K, L, NSW, PERTH); 8 km SW of Denbarker Rd turnoff on Denmark–Mt Barker Rd, 18 Aug. 1979, *J.M. Powell* 1206 (CANB, K, L, MEL, NSW, PERTH); Hunwick South Rd junction with Lower Denmark–Albany Rd, 21 Aug. 1979, *J.M. Powell* 1264 (CANB, HO, K, L, NSW, PERTH); Granite rocks above Cheyne Beach, 22 Aug. 1979, *J.M. Powell* 1291 (AK, CANB, K, L, NSW, PERTH); Boat Harbour Rd, *c.* 4 km SW of South Coast Highway [W of Denmark], 25 July 1982, *J.M. Powell* 1960 (AK, BISH, CANB, HO, K, L, MEL, NSW, PERTH, RSA); 1.2 km N from coastal end of Ledge Point [Beach] Rd [E of Albany], 29 Aug. 1986, *J.M. Powell* 2684 (NSW, PERTH); Lower Kalgan River, 15 Aug. 1951, *R.D. Royce* 3726 (PERTH); Narrikup, 29 July 1953, *R.D. Royce* 4240 (PERTH); by King River, *c.* 1 km SW of King River settlement (N of Albany), 23 Sep. 1982, *A. Strid* 20436 (PERTH); Plot 5454 Boulder Hill [near Two Peoples Bay], 6 Oct. 1992, *G. Wardell-Johnson & A.R. Annels* ARA 2527 (PERTH).

Distribution and habitat. Leucopogon rubricaulis is restricted to near south coast localities between Broke Inlet [W of Walpole] and Cheyne Beach [*c.* 60 km E of Albany] and as far north as the Mount Barker area (Figure 5). This places it within the Warren and Jarrah Forest IBRA bioregions (Department of the Environment, Water, Heritage and the Arts 2008). It grows in a variety of vegetation types in both dry and winter-wet habitats in either deep sand or shallow sandy soils over granite or occasionally laterite.

Conservation status. Although a regional endemic, this is a locally common species which is known to occur in a number of National Parks and Nature Reserves. No conservation coding is recommended here.

Affinities. Despite their superficially similar appearance, the morphological differences between *Leucopogon rubricaulis* and *L. obovatus* are significant. The fruiting character of the former clearly places it in Group C *sensu* Hislop & Chapman (2007) and is qualitatively different from that of *L. obovatus* which was assigned to Group A. In common with the other members of Group C, the drupes of *L. rubricaulis* are oblongoid or narrowly ellipsoid, longitudinally grooved with a truncate apex and

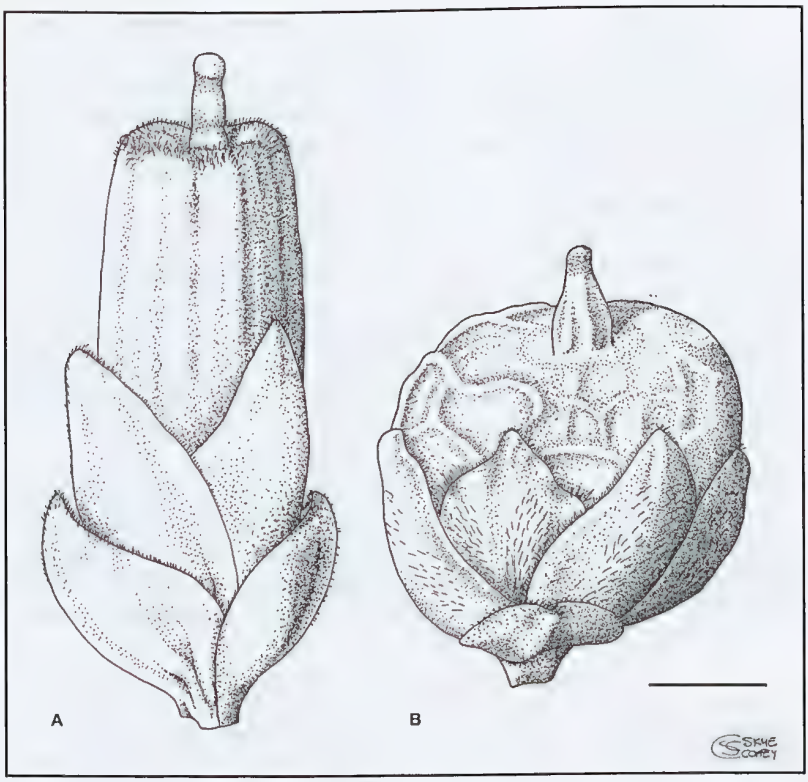

Figure 4. *Leucopogon rubricaulis*. A – fruit. *Leucopogon obovatus* subsp. *obovatus*. B – fruit. Scale bar = 1 mm. Drawn by Skye Coffey from *M. Hislop* 3089 (A), *W. Greuter* 22878 (B).

Figure 5. Distribution of *Leucopogon rubricaulis* in south-west Western Australia.

no mesocarp evident (Figure 4A). In contrast those of *L. obovatus* are globose or depressed-globose, with smoothly rounded shoulders and an obvious mesocarp manifesting as a prominent reticulum on dried specimens (Figure 4B). The two species can also be separated by a different foliar indumentum. Whereas in *L. obovatus* the upper leaf surface has characteristically short, antrorse, tubercle-based hairs (sometimes abraded on older leaves, the surface remaining verrucose), in *L. rubricaulis* it is always smooth and often glabrous. If an indumentum is present, although it may be quite variable, it is never of the kind described above for *L. obovatus*.

The combination of recurved to revolute leaf margins and a usually hairy ovary makes *L. rubricaulis* relatively easy to distinguish from the other members of Group C that occur on the south coast. It could possibly be mistaken for *L. assimilis* R.Br., in that the two species share relatively long, narrow leaves and co-occur in near-coastal habitats around Albany. There is however an obvious difference in the leaf curvature between the two, the leaves of *L. assimilis* being adaxially concave and with the abaxial surface prominently ribbed.

Notes. That *Leucopogon rubricaulis* should have been placed in synonymy under *L. obovatus* (as *L. revolutus*) by Bentham (1868) seems particularly surprising given that fruit of the two species was apparently available to him. The type material of *L. rubricaulis* collected by Brown is fruiting and shows the characteristically elongate and truncate drupe of that species. In Bentham's (1868) description of *L. revolutus* however, the fruit shape is given as 'nearly globular' which although apt for *L. revolutus* is difficult to reconcile with the type of *L. rubricaulis*.

In his description of *L. villosus*, Brown (1810) made mention of a close similarity with *L. rubricaulis*, the two apparently differing only in regard to indumentum. Although the long hairs seen on the vegetative parts of the type of the former are unusual (there are no specimens at PERTH that are closely comparable) there are good reasons to believe that the two should be regarded as conspecific. While a majority of collections of *L. rubricaulis*, including the type, have branchlets and leaves that are either glabrous or very shortly hairy there are a number of specimens with a moderately dense indumentum on these parts. Particularly noteworthy in this regard are three collections made by J.M. Powell at the same site in the Torbay area, west of Albany. Two of these (JMP 1264 and 1265) have glabrous leaves and minutely hairy branchlets, while the third (JMP 1266) has a conspicuous indumentum of quite long hairs covering its vegetative parts. Although perhaps not as extreme as the contrast between the types of *L. rubricaulis* and *L. villosus*, this kind of dimorphism also occurs elsewhere in Group C, notably in *L. pulchellus* Sond. and *L. polymorphus* Sond. Aside from the indumentum, there are no other foliar characters to separate *L. villosus*. In addition, and crucially, although the lectotype of *L. villosus* has very little fertile material present, the remains of an old flower showed the ovary apex to be minutely hairy. This relatively uncommon feature is present in all but a very few collections of *L. rubricaulis*. Examination of a scanned image of type material of *L. angustatus* var. *hirsutus* Sond., suggests that this should also be regarded as a (moderately) hairy variant of *L. rubricaulis*.

Although no type specimens of *L. angustatus* could be located at W, K, or BM, the MEL isotype is typical of *L. rubricaulis* in all respects. Another Hügel collection (MEL 78316) from King George Sound has the characteristic indumentum of *L. obovatus* subsp. *revolutus*. This specimen, from Sonder's herbarium, is annotated in his writing '*Leucopogon villosus* Benth! in Hügel Enumeratio'. This suggests that it is part of the collection that Bentham assigned to *L. villosus* (i.e. no. 266, in Bentham 1837) and provides further indication of Bentham's changing concepts within this group of species.

Lectotypification of *Leucopogon capitellatus* var. *sparsiflorus*

Leucopogon capitellatus DC., *Prodr.* 7(2): 747 (1839). *Type*: 'in Novâ-Hollandiâ ad Swan-river', [Western Australia 1835–1838], *J. Drummond s.n.* (*holo*: G-DC, image seen; *iso*: K 000348344 scanned image seen).

Leucopogon capitellatus DC. var. *sparsiflorus* Sond. [published as β *sparsiflorus*] in J.G.C.Lehmann, *Pl. Preiss.* 1: 312 (1845). *Type*: In glareosis inter frutices montis prope fontem St. Ronan's well [W of York, Western Australia], 25 April 1840, *L. Preiss* 427 (*lecto*, here designated: MEL 2102508!).

Notes. Although common and with a wide distribution throughout the wetter parts of the south-west of Western Australia (from Perth to the Albany area), *Leucopogon capitellatus* is a fairly uniform species with relatively minor variation in leaf size and curvature, indumentum and sepal shape. Because it was collected in April the type of *L. capitellatus* var. *sparsiflorus* has only a few dead flowers present. Just the same, the material is good enough to allow an unequivocal determination that it is typical for *L. capitellatus*. It seems probable that Sonder was misled by the poor quality of the collection, and the limited number of specimens of *L. capitellatus* that were available to him. The inflorescence characters that he used to separate his new variety (i.e. a fewer-flowered, axillary-only inflorescence which was neither spike-like nor capitate) certainly do not hold up in the light of the variation that is observable across the species.

The specimen lectotypified here is from Sonder's personal collection.

Acknowledgements

I would like to thank the following people for their assistance in the preparation of this paper: Skye Coffey for the line drawings and technical support, Alex George for critically examining type specimens of *Leucopogon revolutus* at the British Museum, Juliet Wege for producing the distribution maps and Paul Wilson for nomenclatural advice.

I am also grateful to BM and MEL for the loan of type specimens.

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Amanita ochroterrea and *Amanita brunneiphylla* (Basidiomycota), one species or two?

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Abstract

Davison, E.M. *Amanita ochroterrea* and *Amanita brunneiphylla* (Basidiomycota), one species or two? *Nuytsia* 21(4): 177–184 (2011). *Amanita ochroterrea* Gentilli ex Bas and *A. brunneiphylla* O.K.Miller are robust, macroscopically similar mushrooms described from the south-west of Western Australia. According to the protologue of *A. brunneiphylla,* the main difference between them is the presence (in *A. ochroterrea*) or absence (in *A. brunneiphylla*) of clamp connections. However, in the current study abundant clamp connections have been observed in the holotype and paratypes of *A. brunneiphylla.* As other microscopic characters are indistinguishable, *A. brunneiphylla* is synonymised with *A. ochroterrea,* and an expanded description presented.

Introduction

Amanita species are large, conspicuous mushrooms with a worldwide distribution. They are readily recognized to the generic level in the field, but the majority are difficult to separate into species solely on their appearance. Microscopic characters are usually needed before collections can be confidently identified. The most commonly used microscopic characters are spore size and shape, their response to Melzer's iodine, the presence of clamp connections in the basidiome especially at the base of basidia, the structure of the subhymenium and underlying lamella trama, the pileipellis, and the structure of the universal veil on the pileus. All of these characters are used to separate species and construct diagnostic keys (Bas 1969; Reid 1979; Tulloss 1994; Wood 1997).

In 1953 Gentilli described several collections of *Amanita* spp. from Kings Park, Perth, Western Australia which included two large specimens with an earthy buff cap, buff lamellae and pale buff spore print that he called *A. preissii* (Fr.) Sacc. forma *ochroterrea* Gentilli (Gentilli 1953). This forma was not validly published since it was not accompanied by a Latin description or diagnosis. Gentilli sent these specimens to Bas who considered them to be so distinctive that he described them as a new species, *A. ochroterrea* Gentilli ex Bas (Bas 1969; MB308574).

Following a visit to the south-west of Western Australia in 1989, Miller described *A. brunneiphylla* O.K.Miller (MB358165), a robust species with a dull white cap, light brown lamellae and a pale yellow spore print. He recognised that this was similar to *A. ochroterrea*, but separated the two species on the presence (in *A. ochroterrea*) or absence (in *A. brunneiphylla*) of clamp connections, together with small differences in spore size and colour of the lamellae (Miller 1991).

This paper reports a re-examination of the holotype and paratypes of *A. brunneiphylla* held at the Western Australian Herbarium (PERTH). These are compared with the published description of *A. ochroterrea*. Additional collections named as *A. ochroterrea* in PERTH, and macroscopically similar specimens held in private collections in Western Australia have also been examined. As a result, *A. brunneiphylla* is synonymised with *A. ochroterrea* and an expanded description is provided.

Materials and methods

Methodology follows that of Tulloss (2000, 2008). Colours are from the Royal Botanic Garden, Edinburgh (1969) and colour codes in the form of 'p3A2' are from Kornerup and Wanscher (1978). Dried material was rehydrated in 10 % NH_4OH or 3 % KOH and stained with 1 % Congo Red. Biometric variables for spores follow Tulloss and Lindgren (2005), i.e. '**L** = the average spore length computed for one specimen examined and the range of such averages, **L′** = the average spore length computed for all spores measured, **W** = the average spore width computed for one specimen examined and the range of such averages, **W′** = the average spore length computed for all spores measured, Q = the ratio of length/breadth for a single spores and the observed range of the ratio of length/breadth for all spores measured, **Q** = the average value of Q computed for one specimen examined and the range of such averages, **Q′** = average value of Q computed for all spores measured'.

Comparison of *Amanita ochroterrea* and *A. brunneiphylla*

The macroscopic descriptions of *A. ochroterrea* and *A. brunneiphylla* are similar; however, the protologue of *A. brunneiphylla* states that the flesh is 'firm, dull white tinted grey at the base' (Miller 1991). An image (E567) of a paratype (PERTH 007565259, *O.K. Miller* OKM 23747, as reproduced in Figure 1A, shows that the flesh is tinted brown, however, this may have resulted from drying. Neither Gentilli (1953) nor Bas (1969) comment on the colour of the context.

The microscopic characters of the holotype and paratypes of *A. brunneiphylla* do not differ from the type description of *A. ochroterrea* (Table 1). Basidiospore dimensions, amyloid reaction, size of basidia, and shape of lamella edge cells in all mature collections are similar to those of the type description of *A. ochroterrea*. Clamp connections are present and abundant in all of these collections; thus the original description of *A. brunneiphylla* is neither supported by the holotype nor the paratypes.

These observations did not detect any significant differences between these taxa. As a result, *A. brunneiphylla* is synonymised with *A. ochroterrea*. An expanded description of *A. ochroterrea* is provided.

Expanded description of *Amanita ochroterrea*

Amanita ochroterrea Gentilli ex Bas, *Persoonia* 5: 505–506, figures 278–281 (1969). *Amanita preissii* (Fr.) Sacc. f. *ochroterrea* Gentilli, *W. Austral. Naturalist* 4: 30, figure 3 (1953), (*nom. inval.*, Art. 36.1). *Type*: Perth, Kings Park, Western Australia, June 1953, *J. Gentilli s.n.* (*holo*: L). (MB308574).

Amanita brunneiphylla O.K.Miller, *Canad. J. of Bot.* 69: 2694 (1991). *Type*: Murdoch University campus, Western Australia, 7 May 1989, *O.K. & H.H. Miller, E.M. & P.J.N. Davison* OKM 23621 (*holo:* PERTH 07587473, image E 511). (MB358165).

Basidiome small to very large (Figures 1A, B). *Pileus* 35–170 mm diam, up to 15 mm thick, hemispheric when young, becoming more or less plane with a depressed centre with age, cream, pale buff to pale olivaceous buff (p1A2–p2B4–p4B3), margin of the pileus appendiculate, non-sulcate, no surface staining or bruising reaction. *Universal veil on pileus* (Figure 1C) adnate, forming a soft thin crust over the whole pileus, sometimes with small floccose warts in the centre, sometimes with thick felty angular flattened warts in the centre, cream, pale grey olivaceous, pale vinaceous buff, pale buff to pale olivaceous buff (p1A2–p3B5–p4B3). *Lamellae* close, free to narrowly adnate, 5–15 mm broad, ventricose, buff, olivaceous buff, hazel (p1B2–p5C4–6), drying buff to snuff brown (p5C4–F7), often with two tiers of plentiful lamellulae, the shorter truncate, the longer attenuate, lamella margin lighter in colour and slightly fimbriate. *Stipe* length (bottom of pileus context to top of bulb) 60–115 mm; width at mid-stipe 14–37 mm, more or less equal, solid, pale olivaceous buff, pale buff (p2B4–p4B3), furfuraceous or covered in mealy scales below the partial veil. *Partial veil* superior, descendent, soft, fugacious, initially greenish cream darkening to pale olivaceous buff (p1A2–B2). *Bulb* 55–72 × 28–44 mm, initially ovoid, narrowing with age, olivaceous buff, encrusted with sand. *Remains of universal veil* at the base of the stipe soft ridges and scales, in some specimens forming girdles; loose patches often remaining in the soil. *Flesh* cream, straw, to pale olivaceous buff (p1A2–p2B5) in both pileus and stipe, sometimes darkening on exposure to air. *Smell* mild and earthy when young, stronger when older. *Spore deposit* cream (p3A2–3) to buff.

Figure 1. *Amanita ochroterrea*. A – showing the brownish colour of freshly exposed flesh (paratype of PERTH 07565259, *O.K. Miller* OKM 23747); B – *Amanita ochroterrea* (PERTH 08334897, B-S 168); C – surface of pileus (PERTH 08059632, *E.M. & P.J.N. Davison* EMD 6-2008). Photographs by N.L. Bougher (A), L.I. Little (B) and E.M. Davison (C)

Table 1. Comparison of the type descriptions of *Amanita ochroterrea* and *A. brunneiphylla* with observations from holotype and paratype collections of *A. brunneiphylla*.

	A. ochroterrea type description (Bas 1969)	*A. brunneiphylla* type description (Miller 1991)	*A. brunneiphylla* PERTH 07587473 holotype	*A. brunneiphylla* PERTH 07587562 paratype	*A. brunneiphylla* PERTH 07564465 paratype	*A. brunneiphylla* PERTH 07565259 paratype
Basidiospores L × W (µm)	(10–)11–13 (–13.5) × 5–6.5 (20/1)	(8–)9–10.8 × 4.1–5	(8–)9–12 × 4.5–5 (20/1) from lamella	no spores, basidia immature	no spores, basidia immature	(8.5–)9.5–11(–11.5) × 4.5–6 (15/1) from lamella
Q	1.9–2.4, mean 2.1	1.8–2.3, mean 2.1	2.0–2.7, mean 2.2			1.7–2.3, mean 2.0
Amyloidy	amyloid	amyloid	amyloid			amyloid
Basidia L × W (µm)	50–55 × 11–12	34–38 × 7–10	38–45 × 9–10	basidia immature	basidia immature	30–50 × 9–11
Lamella edge cells (size in µm)	globosetoclavate, 15–35 × 15–20	pyriform to clavate, 18–26 × 9–15	pyriform to clavate, up to 25 × 12	clavate to spherical, 15–40 × 10–15	clavate to pyriform, 20-28 × 14-20	globose, clavate to cylindric, <20 wide
Subhymenium	probably ramose	isodiametric cells	inflated ramose	ramose	ramose	ramose
Clamp connections	present at base of basidia and in pileipellis	none seen in any tissue	present and abundant in all tissues	Present and abundant in all tissues	present and abundant in all tissues	Present and abundant in all tissues

Basidiospores (Figure 2A) [161/9/8] (8–) 9.5–13(–15) × (4–)4.5–6 (–6.5) µm, **L** = 10.1–11.7 µm; **L′** = 11.0 µm; **W** = 4.7–5.6 µm; **W′** = 5.2 µm; Q (1.67–) 1.82–2.44(–3.00), **Q** = 2.00–2.23; **Q′** 2.13) hyaline, colourless, thin-walled, smooth, amyloid, elongate to cylindrical, infrequently bacilliform, adaxially flattened, with apiculus sublateral, truncate, about 1 × 1 µm, with granular contents. *Pileipellis* difficult to delimit, merging into both universal veil and pileus context, not or slightly gelatinized at the centre, gelatinization of the hyphal walls in some specimens near the pileus margin; hyphae 2–10 µm wide, thin walled, hyaline, orientation mainly radial with some interweaving. *Pileus context* tissue yellow in NH_4OH, hyphae 6–30 µm wide, thin walled, hyaline, dominant, mainly with radial orientation; inflated cells up to 60 × 250 µm, thin walled, colourless. *Lamella trama* bilateral; width of central stratum 40–60 µm, hyphae 5–20 µm wide, no inflated cells seen; subhymenial base 25–60 µm wide, hyphae 4–20 µm wide, dominant orientation is initially about 30° from the vertical with the hyhae bending round in a smooth curve to the subhymenium, inflated cells up to 20 × 70 µm, infrequent; subhymenium (Figure 2B) 20–40 µm wide, ramose to inflated ramose, thin-walled; lamella margin cells (Figure 2C) globose, pyriform to clavate up to 10–15 × 25–40 µm. *Basidia* [132/7/7] (30–)35–60(–65) × (7.5–)9–11(–12.5) µm, thin-walled, yellow contents in NH_4OH, about 90 % four-spored about 10 % two-spored, sterigmata up to 5 µm long by 2 µm wide at the base; basal clamps present. *Universal veil on the pileus* (Figure 2E) comprising abundant mainly ellipsoidal to spherical, rarely pyriform to clavate, venticose to fusiform cells up to 70 × 150 µm, but most smaller, inflated cells terminal or in short chains; filamentous hyphae 5–10 µm wide, frequently branched, irregularly disposed, hyphae more abundant in the proximal part of the universal veil, while the inflated cells are more abundant in the distal part of the universal veil; some gelatinization of the walls of both filamentous and inflated hyphae evident in older specimens. *Universal veil on the stipe base* disordered tissue of terminal spherical and clavate cells up to 30 × 150 µm and filamentous hyphae 3–12 µm wide. *Stipe context* acrophysalidic, with acrophysalides up to 30 × 300 µm dominant, filamentous hyphae 3–13 µm wide with mainly axial orientation. *Partial veil* (Figure 2D) of dominant spherical to clavate or pyriform inflated cells 15–20 × 50 µm, but occasionally up to 30 × 300 µm, and infrequent, mainly radial, filamentous hyphae 2–8 µm wide. *Vascular hyphae* present but infrequent in all tissues, 2–15 µm wide, occasionally branched, thin walled, with yellow glassy contents in NH_4OH, frequently serpentine, no knots or concentrations of vascular hyphae noted in any tissue. *Clamp connections* present and frequent in all tissues.

Collections examined. WESTERN AUSTRALIA: Murdoch University campus, 25 Apr. 1990, *E.M. & P.J.N. Davison* EMD 12-1990 (PERTH 08059640); Melville, 12 May 2008, *E.M. & P.J.N Davison* EMD 6-2008 (PERTH 08059632); near Southern Cross, 23 June 1974, *B. Dell & K. Elson s.n.* (PERTH 00768804, UWA 1862); Swan View, 20 May 2005, *K. Griffiths* B-S 168 (PERTH 08334897); Murdoch University campus, 7 May 1989, *O.K. & H.H. Miller, E.M. & P.J.N. Davison*, OKM 23621 (PERTH 07587473, E 511 holotype of *A. brunneiphylla*); Kings Park, 21 May 1989, *O.K. & H.H. Miller* OKM 23660 (PERTH 07587562, E 529 paratype of *A. brunneiphylla*); Moore River, 23 May 1989, *O.K. & H.H. Miller* OKM 23720 (PERTH 07564465, E 560 paratype of *A. brunneiphylla*); Regans Ford, 30 May 1989, *O.K. & H.H. Miller* OKM 23747 (PERTH 07565259, E 567 paratype of *A. brunneiphylla*); Kings Park, 26 May 1982, *anon. s.n.* (PERTH 07607512, E 239).

Rejected collections. Corrigin shire, *J. Catchpole, I.C. Tommerup & N.L. Bougher s.n.*, 8 July 1999 (PERTH 07658508, E 6235); Grass Patch, *T.C. Daniell s.n.*, 18 Aug. 1984 (PERTH 00918326, UWA 2966) (green form); Gleneagle, *R.N. Hilton s.n.*, 18 June 1975 (PERTH 00771961, UWA 2001); Walpole Nornalup National Park, *K. Syme* 29:87, 24 May 1987 (PERTH 07575270, UWA 3510).

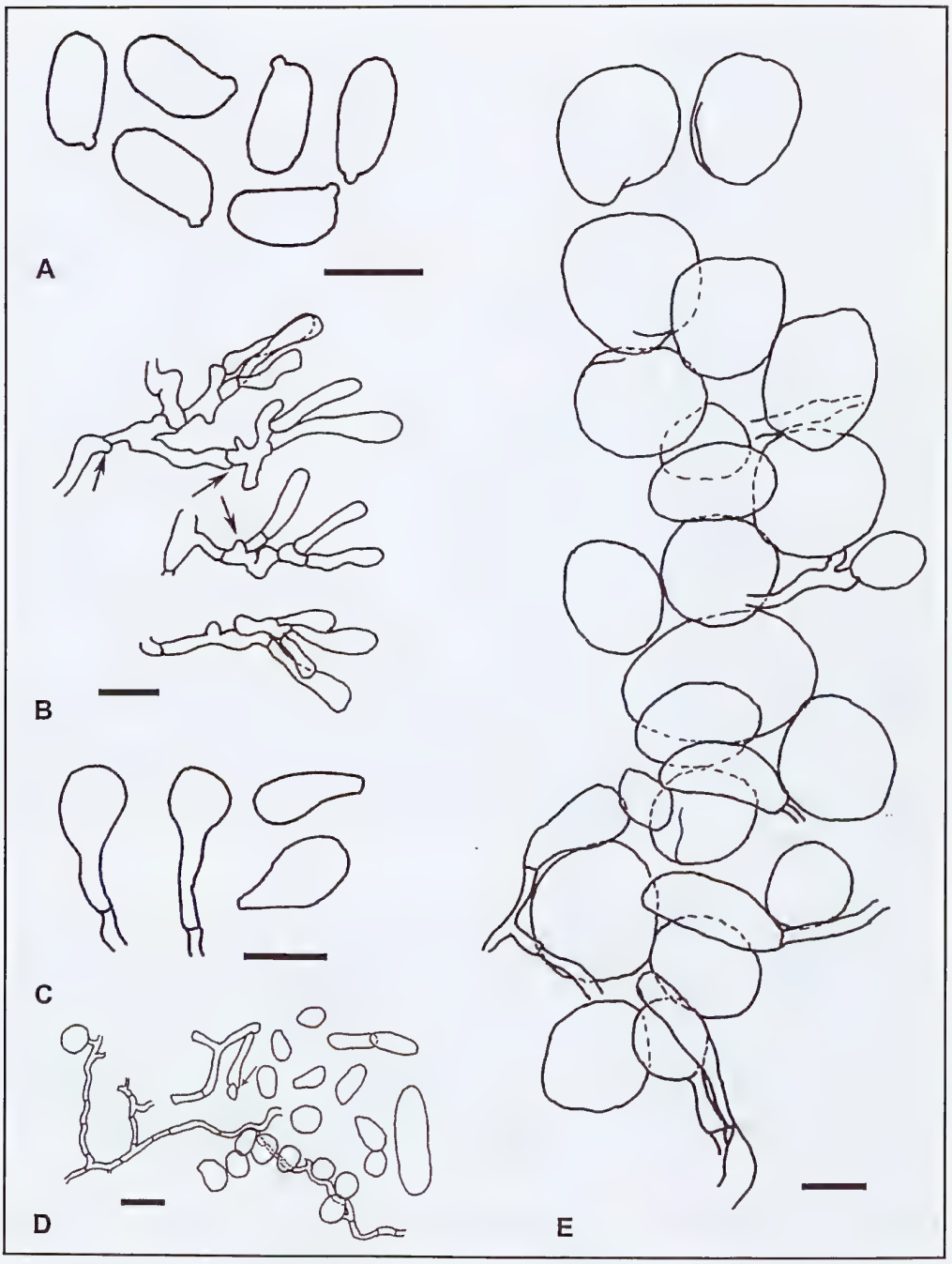

Figure 2. *Amanita ochroterrea*. A – spores from spore print; B – squash of young basidia and subhymenium, clamp connections indicated by arrows; C – lamella edge cells; D – cells from the partial veil, clamp connection indicated by an arrow; E – vertical section through the universal veil on the pileus, the proximal part is at the bottom. A, C, D, E (PERTH 08059632, *E.M. & P.J.N. Davison* EMD 6-2008); B (PERTH 07587562 *O.K. Miller* OKM 23660, paratype of *A. brunneiphylla*). Scale bars A = 10 μm, B–E = 20 μm.

These collections have been rejected for the following reasons: PERTH 07658508 has a saccate volva and probably resides in Section *Amidella*; PERTH 00771961 and PERTH 07575270 have been rejected because they have low **Q**: 1.64 and 1.72 respectively; PERTH 00918326 has a much wider central stratum and wider lamellae.

Distribution and habitat. Solitary or gregarious, in sandy soil in dry sclerophyll woodland and sand plain, often associated with *Eucalyptus marginata* Sm. and *Corymbia calophylla* (Lindl.) K.D.Hill & L.A.S.Johnson. *Amanita ochroterrea* is a distinctive species that is widely distributed in the south-west of Western Australia from the Moore River (31°00′ S, 115°30′ E) to Southern Cross (31°13′ S, 119°18′ E) although it does not appear to be common. It has not been recorded in South Australia (Grgurinovic 1997) or eastern Australia (Wood 1997).

Fruiting period. April to August.

Diagnostic features. Robust basidiomes with buff pileus, brown gills, yellowish spore print and clamp connections throughout.

Suggested common name. Brown-gilled amanita.

Notes. Bas (1969) placed *A. ochroterrea* in *Amanita* (subsection *Solitariae* Bas) Stirps *Grossa* in part because of the irregularly disposed remnants of the universal veil on the pileus. He commented, however, that these remnants were difficult to analyse. The collections examined here support Bas' placement of *A. ochroterrea* in Stirps *Grossa* because the basidia have clamp connections, **Q** is less than 2.2, the universal veil on the pileus forms a subfelted layer and is composed of irregularly disposed inflated cells intermixed with hyphae.

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Referees for Volume 21

The assistance of referees in providing expert review of papers submitted to *Nuytsia* is gratefully acknowledged. The referees consulted for Volume 21 include those listed below. Each paper was also refereed internally by *Nuytsia* Editorial Committee members.

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CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA

T: Threatened Flora (Declared Rare Flora — Extant). Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the *Wildlife Conservation Act 1950*). Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria:

CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild.
EN: Endangered – considered to be facing a very high risk of extinction in the wild.
VU: Vulnerable – considered to be facing a high risk of extinction in the wild.

X: Presumed Extinct Flora (Declared Rare Flora — Extinct). Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the *Wildlife Conservation Act 1950*).

1: Priority One: Poorly-known taxa. Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.

2: Priority Two: Poorly-known taxa. Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.

3: Priority Three: Poorly-known taxa. Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.

4: Priority Four: Rare, Near Threatened and other taxa in need of monitoring.

Rare: taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.

Near Threatened: taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. Taxa that have been removed from the list of threatened taxa during the past five years for reasons other than taxonomy.

5: Priority Five: Conservation Dependent taxa. Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

CONTENTS

Papers

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